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Sitta pusilla. BROWN-HEADED NUTHATCH. In company with the preceding and with Red-cockaded Woodpeckers. Five.

Baeolophus bicolor. TUFTED TITMOUSE. Fifteen.

Penthestes carolinensis carolinensis. CAROLINA CHICKADEE. Twenty.

Regulus calendula calendula. RUBY-CROWNED KINGLET. A singing male at Orton, April 18.

Poliophtila caerulea caerulea. BLUE-GRAY GNATCATCHER. Five.

Hylocichla mustelina. WOOD THRUSH. Song heard at Wilmington, April 19.

Sialia sialis sialis. BLUEBIRD. Three.

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MIGRATION AND PHYSICAL PROPORTIONS. A PRELIMINARY STUDY.

BY C. K. AVERILL

IT is a matter of common observation that birds most capable of long sustained flights are long winged. Such are the swallows and swifts on land and the terns, plovers and sandpipers along the shore.

A bird flying 35 miles per hour passes through the air at the rate of 51 feet per second and the form of the tail evidently has much to do with the resistance offered by the air. It is evident that the stream lines that pass under the body of the bird will converge at the rear of the body, striking against the tail and causing undue pressure. In birds of superior power of flight—terns, swallows, swifts, gulls, kites, the tail is either forked or it is short, in either case there is little tail beyond the end of the under tail coverts in the median line.* It is the mechanical function of the under tail coverts to fill in the angular space where the tail joins the body where without the coverts an area of reduced pressure would be formed increasing the resistance. The tail of the barn swallow,

*In the soaring hawk or eagle the large broad tail forms one of the three planes which support the body.

deeply forficate, is part of Nature's ornamental scheme and such tails occur in terns, kites, swallows, where elegance of form and beauty and great ease of flight are combined. We shall find that among similar birds the species with the longer wings has a shorter or more emarginate or forked tail.

These two points, long wing, and tail of small area we may observe in the flying bird, but if we hold our bird in the hand, be it swallow or swift, we also notice that it has small feet and legs. Apparently Nature takes pains in reducing all superfluous weight and carefully considers all trifles. Among the economies the elimination of the hind toe appears to be included. Thus in the true snipe represented by the woodcock, Wilson's Snipe and Dowitcher the hind toe is present. In the sandpipers which are much longer winged it is much smaller and in the Sanderling which seems the lightest and best formed of these birds and which makes an annual flight of 2000 miles across the ocean to the Sandwich Islands, the hind toe vanishes entirely. Again in the plover family it is present in the Lapwing and Surf-bird, rudimentary in the Black-bellied Plover and is obliterated in the Golden Plover, whose migratory flights so astonish us.

In the petrels, those long winged birds of the sea, the hind toe is minute or lacking entirely. Can these instances be regarded as fortuitous?

Along the same line we notice that the bill of our swallow or swift is extremely small although we cannot see that a larger bill would interfere with the capture of the insects which these birds feed upon. What we see is the cutting out of all surplus material.

In the terns the feet are reduced in size very much as compared with the gulls. The bill, however, cannot be reduced and be effective in catching fish. Reduction is possible only when not interfering with the life of the bird.

We have then four points of a good flier,—long wing, short tail, or tail of small area, small bill and small legs as shown by length of tarsus. It is one object of this paper to show that the better equipped birds in these respects, in any group, have a greater migratory range.

We will tabulate the genus *Helminthophila* from Ridgway's 'Birds of North and Middle America,' using measurements of

the male bird always. The first column contains the name of the bird, the second a brief statement of its range, the third the wing length, the fourth the tail length, the fifth column the difference between wing and tail lengths. It is this column that shows at a glance that the bird making the long migration, is also best proportioned for flight. Measurements in millimeters.

HELMINTHOPHILA.

Species	Range	Wing	Tail	Diff.	Cul.	Tars.
Tennessee Warb.	E. N. A. N. E. New York to to Alaska. In winter to Venezuela	64.5	42.5	22.1	9.6	16.8
Bachman's	So. States to Cent. Am.	58.9	44.2	14.7	11.4	17.3
Blue-winged	S. N. Eng. to Guatemala	60.2	46.0	14.2	10.7	17.3
Golden-winged	Mass. to Colombia	62.2	46.2	16.0	10.7	17.5
Nashville	Saskatchewan to Colombia	59.2	43.9	15.3	9.5	17.0
Calaveras	Brit. Col. to Mexico.	60.2	45.5	14.7	9.6	16.8
Virginia's	Mt. Dist. Color. to Mexico	61.2	46.0	15.2	9.4	17.0
Lucy's	Arizona and Mexico	52.1	38.6	13.5	8.4	15.5
Orange crowned	Alaska to Mexico	62.2	50.0	12.2	9.6	17.8
Lutescent	Pacific Coast—Alaska to Guatemala	59.9	47.0	12.9	9.4	18.0
Dusky	Calif. Santa Barbara Is. and adjoining mainland.	59.2	49.8	9.4	11.4	18.3

Here we see by the figure opposite the Tennessee Warbler, 22.1, that it is the bird making the longest migration. At the end of the list is the Dusky Warbler, 9.4, showing the longest tail of all and the shortest wing relatively. We notice that it carries a larger bill and tarsus than the Tennessee in accordance with what we have already said.

In the same way we may compare the Orange-crowned, Lutescent and Dusky, three races of the same species and note the better flying characteristics of the two birds that reach Alaska.

Let us in the same way make a table of the genera *Oporornis* and *Geothlypis*.

These six birds are arranged in order of their relative wing and tail lengths. With the exception of the Kentucky they also come in order of the extent of their migratory range. While the tail and wing vary greatly the bill and feet remain very much alike

in size. It is evident from this table and the preceding that the important features are wing and tail. The increase in wing length is mostly in the primaries so that the long wing is a pointed wing as in the Connecticut and Kentucky, and the short wing is a round wing as in the Yellow-throat. With the round wing goes the round tail while the long wing accompanies the even tail.

OPORORNIS AND GEOTHLYPIS.

		Wing	Tail	Diff.	Cul.	Tar.
Connecticut Warb.	E. N. A. North Mich. to Brazil	73.1	49.8	23.3	11.9	21.3
Kentucky	E. U. S. Hudson Valley to Colombia	70.1	51.0	19.1	11.9	22.3
Mourning	E. N. A. Canadian Zone, winters from Nicaragua to Ecuador	61.5	49.0	12.5	11.4	20.8
Macgillivray's	W. U. S. Breeds from Brit. Col. So. to New Mex. In winter from Lower Calif. to Colombia.	62.2	55.6	6.6	11.4	21.6
Northern Yellow-throat.	So. Canad. to Costa Rica.	55.1	49.2	5.9	11.4	20.5
Florida Yellow-throat.	Gulf States. Winters in W. I.	55.2	53.0	2.2	11.5	20.7

YELLOW-THROATS.

		Wing	Tail	Diff.	Cul.	Tars.
Maryland	Atlantic Coast districts of U. S. Winters in W. I.	52.9	49.3	3.6	10.5	20.1
Northern	N. E. U. S. and S. E. Brit. Provinces. In winter to Guatemala.	55.1	49.2	5.9	11.4	20.5
Florida	Gulf States. Winters in W. I.	55.2	53.0	2.2	11.5	20.7
Western	Arid regions of U. S. In winter to Mexico.	57.5	55.8	1.7	11.3	20.9
Pacific	Pacific Coast—Brit. Col. to Calif. Winters in Cape St. Lucas.	55.8	52.6	3.2	10.3	20.4
San Blas	Mexico only.	55.3	51.1	4.2	11.4	20.8
Salt Marsh	California	52.6	48.3	4.3	10.2	19.9
Japala	Mexico	61.2	60.2	1.0	11.2	21.0

Of these eight geographical races the longest migration is made by the Northern Yellow-throat which has the shortest tail in relation to wing. It is important to notice that the southern, western and Mexican birds are all longer tailed with the exception of the salt marsh race. We often read in the text books that western races have longer tails, but it is seen in this table as well as in the others that it is the bird of limited range that has this characteristic, rather than the bird of any particular region.

It will be of interest to tabulate the whole genus *Dendroica* on account of the number of species and because we have great differences in length of annual journeys—from thousands of miles each year to zero.

DENDROICA I. BREEDING IN HUDSONIAN AND CANADIAN ZONES. IN WINTER IN SOUTH AMERICA.

	W.	T.	Diff.	Culm.	Tars.
Blackpoll Warbler	74.2	51.3	22.9	10	19.1
Bay-breasted	73.4	53.1	20.3	10.4	18.3
Blackburnian	67.8	48.3	19.5	9.9	17.5
Yellow	62.5	44.4	18.1	10.1	18.6
Average	69.5	49.3	20.2	10.1	18.4

DENDROICA II. BREEDING IN SOUTHERN STATES. WINTER IN S. A.

	W.	T.	Diff.	Culm.	Tars.
Cerulean	65.5	45.0	20.5	9.9	16.5

DENDROICA III. ALASKA TO LABRADOR. NOT BREEDING S. OF CANADIAN ZONE. WINTERING U. S. TO PANAMA.

Myrtle	74.1	56.2	17.9	10.	19.6
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DENDROICA IV. BREEDING IN CANADIAN ZONE. NOT REACHING SOUTH AMERICA IN WINTER.

Cape May	66.3	47.2	19.1	9.8	17.8
Yellow Palm	67.1	54.6	12.5	9.9	20.0
Black-throated Blue	65.2	51.1	14.1	9.4	18.7
Black-throated Green	63.8	47.8	16.0	10.2	17.3
Magnolia	60.1	48.7	11.4	9.0	17.8
Average	64.5	49.9	14.6	9.8	18.3

DENDROICA V. BREEDING S. OF CANADIAN ZONE. NOT REACHING
S. AMERICA IN WINTER.

Prairie	57.6	47.8	9.8	9.4	18.3
Kirtland's	71.4	58.8	12.6	11.9	22.3
Pine	72.9	54.4	18.5	10.9	18.5
Yellow-throated	66.9	50.7	16.2	13.8	17.4
Chestnut-sided	63.3	50.1	13.2	9.6	17.8
Average	66.4	52.3	14.1	11.1	17.9

DENDROICA VI. WEST INDIAN SPECIES. NOT MIGRANTS.

	W.	T.	Diff.	Cul.	Tar.
Jamaica Yellow	65.0	50.3	14.7	10.6	20.5
Guadaloupe	58.4	45.5	12.9	10.4	19.1
Panama	66.0	49.5	16.5	11.0	20.
Adelaide's	50.	42.3	7.7	10.0	18.6
Santa Lucia	56.	51.	5.0	10.1	18.2
Cuban	58.9	49.4	9.5	10.3	16.4
Vittelline	56.8	51.0	5.8	11.0	19.8
Plumbeous	61.9	54.1	7.8	11.0	20.3
Streaked	62.8	51.1	11.7	11.3	18.8
Average	59.5	49.4	10.2	10.6	19.1

Taking the genus *Dendroica* the difference is almost entirely in wing length, the tail does not differ as it does when comparing geographical races, nor do the bill and tarsus differ much.

In this genus as in the others preceding we can certainly "pick the winner" by relative length of wing and tail. The Blackpoll is one of the most famous of all passerine birds as a migrant. Quoting from Cooke "the shortest journey any blackpoll performs is 3500 miles while those that nest in Alaska have 7000 miles to travel to their probable winter home in Brazil" and we find it showing the maximum difference between length of wing and tail 22.9. The Bay-breasted, Blackburnian and Yellow Warbler all of which reach South America in their flight show a difference of 20.3, 19.5 and 18.1 respectively.

We note that the Cerulean Warbler although it does not go far north is well proportioned for flight (difference 20.5) and it will be found that the shorter winged species neither go far north nor to South America.

I have tabulated measurements for birds of other families and the same principle seems to hold good in nearly every case, though

of course in birds such as swallows and swifts and others especially adapted for continuous flight the points I have called attention to are not noticeable. It would be useless to multiply examples as the other tables simply emphasize what I have shown in the Warblers.

SUMMARY.

We have seen that the longest migrations in any group of similar birds are made by those with longer wings, smaller tails, and smaller bills and feet, and from observation of birds of highly developed powers of flight we conclude that flight is easier for birds so proportioned.

We know that migratory flights are a tax on the strength and endurance of birds, that they cross considerable bodies of water that in order to arrive in spring with the punctuality which many of them attain, they fly under unfavorable conditions, against adverse winds, in stormy weather, and are often found exhausted by the struggle. Perhaps if we recall some of the cases of warblers in distress we have witnessed or read of we remember that such long winged species, as Blackpolls, Myrtles, Yellows, Oven birds, Water-Thrushes, fared better than the shorter winged Yellow throats, Parulas, Redstarts. It is logical to conclude that by natural selection nature develops the characteristics of good flight and the fittest survive.

If birds extended their range by sudden expeditions to some distant point then we might suppose the long winged birds had simply beaten the short winged. Perhaps to some extent this has happened. We may suppose that the Starling with its excellent wing and tail for flight will extend its range more rapidly than some bird of poor flight power. But when we look at the table of Yellow Warblers or of Parula Warblers the differences in physical proportions are so slight that it seems they could not be, as they are, important factors in acquiring range. They seem rather to be incipient developments that will increase with time.

The forked tail accompanies the longer wing in our North American migrants and is an evidence of good power of flight.

The birds of the west, those of and beyond the Rocky Mountains, while they may go far north to breed, many of them to

Alaska, do not go far south in winter since the climate of our southwestern states and that of Mexico is such that food cannot be procured at that season. Their migratory flights are so much shorter than those of our eastern birds that they have generally poorer proportions for flight these conditions being particularly noticeable in the birds of the southwestern states, where so many are resident. This region then is the metropolis for long-tailed, short-winged, large-billed and large-legged birds. The Florida races are of the same sort but much fewer in numbers.

Life for the bird is mainly a struggle for food, and this implies a struggle for room, for extension of feeding grounds and breeding places. In this struggle those with good flight abilities and vigor are found to have the widest distribution for it is written in the book of birds that the longed-winged shall inherit the earth.

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GENERAL NOTES

Roseate Tern (*Sterna dougalli*) Breeding in Virginia.—While spending six weeks during the spring of 1920 along the coast of Virginia, I visited every island from Cobb's to Cape Charles, and was surprised and gratified to find the Roseate Tern breeding on three of these islands, namely, Cobb's, Wreck and Isaac's. They were in small groups of three or four pairs in company with Common Terns. I found them to be much more pugnacious than the Common Tern, and while darting at an intruder, would come so close that there was no doubt as to their identity. As Bailey, in his 'Birds of Virginia' does not mention this as a breeding bird of the State, I deem this fact worthy of record.—B. R. BALES, M.D., Circleville, Ohio.

Egret at South Orleans, Mass.—Mr. E. B. Mecarta, of Harwich, has given me the following facts in regard to the capture of an American Egret (*Herodias egretta*) at South Orleans, Mass. On July 26, 1920, Mr. John Kendrick saw a large white heron in a small pond near the state road, and on July 29 the bird was again noticed in the same pond flapping violently as if injured. Upon investigation the heron proved to have had one foot nearly severed probably by a snapping turtle, and was captured from a boat. Mr. Mecarta amputated the foot, and delivered the bird alive to the Curator of the Franklin Park Museum, where it was left in apparently good health on August 2. Strong southwest winds which had